Evolution-Informed Maternal-Infant Health

Helen L. Ball, Parent-Infant Sleep Lab., Department of Anthropology, Durham University, UK

Can applying an evolutionary perspective generate effective change in clinical care and/or public health policyAn evolution-informed research programme has changed practice on UK post-natal units and UK health policies on infant care over the past two decades.

Human infants are secondarily altricial mammals, requiring close contact with a carer for safety and warmth, and frequent feeding by mothers who produce milk that is low in fat, high in sugar, and thus quickly digested. The rapid postnatal brain growth of human infants involves a high degree of active sleep, frequent night-waking, and no circadian rhythm for several months. This view of early infancy and new motherhood requires us to consider mother-infant biology as a complex and inter-related outcome of a particular evolutionary history. We therefore emphasise that to be effective, health-care policies and practices should support the optimum functioning of this dyadic evolved biology in contemporary contexts. Moreover, evolutionary parental-investment theory helps us to understand that, although they are two parts of an integrated biological system, the mother-infant relationship is not necessarily harmonious; tension exists between the needs of the highly dependent human infant and the willingness or ability of the mother (who shares only half of its genes) to respond to those needs, resulting in trade-offs in the management of infant care.

In the Sleep Lab, we try to understand how parents attempt to cope with night-time care in early infancy using an understanding of our mammalian, primate and hominin evolutionary history [1], and the application of evolutionary parental investment theory (particularly parent-infant conflict) Our research has focussed on how parents resolve these consequences of our evolutionary history, particularly at night, with the aim of helping health professionals and parents themselves to understand both the feelings of conflict, and the decisions parents make.[3]

Where might my baby sleep?

Our initial research focus was on the intersection between infant-related parental sleep-disruption and breastfeeding cessation, taking account of the economic and reproductive needs of a contemporary environment. A recurring theme that emerged was the intricate conflict between the night-time needs of infant feeding and parental sleep. In our earliest studies we found that some mothers terminated breastfeeding a few weeks into their babies' lives because of the sleep-disruption attendant on frequent night-feeds. Supplementing their babies' diets enhanced perceived sleep and reduced night-time mother-infant conflict.[4] However, mothers committed to breastfeeding implemented alternative strategies to reduce the costs of frequent feeding (and thereby night-waking). These mothers reported that sleeping with their babies (bed-sharing) served as an effective compromise strategy. We repeatedly found that 70-80% of breastfeeding mothers regularly bring their babies into bed to feed and then to sleep, compared with 38% of mothers who do not breastfeed.[5, 6] This strategy works to reduce conflict and postpone breastfeeding cessation; in a prospective study of 870 mother-infant dyads with a prenatal intention to breastfeed, we found that twice the proportion of those who sometimes or regularly bed-shared in the first 3 months were still breastfeeding at 6-months of age compared to those who reported they never slept with their babies.[7]

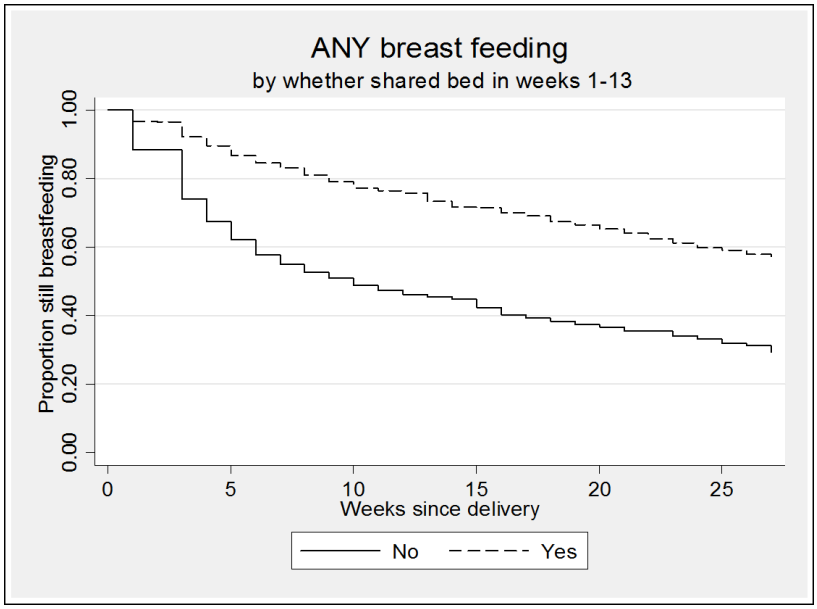

Figure 1 –Bed-sharing is strongly associated with breastfeeding continuation (Ball et al 2016).

The UK has one of the poorest breastfeeding continuation rates in the world[8], and these research outcomes have shed new light on how practice and policy can better support breastfeeding. The findings were taken up within the NHS and breastfeeding support NGOs and national guidance now insists that UK health professionals discuss infant feeding and sleeping strategies with mothers, inform them of the likelihood of sleeping with their baby when feeding at night, and provide them with guidance on how to make their bed as safe as possible. Our evolutionary-informed research has therefore contributed to a balanced guidance policy in the UK regarding infant feeding and sleeping, with emphasis on parental informed choice (e.g. www.unicef.org.uk/babyfriendly/baby-friendly-resources/leaflets-and-posters/caring-for-your-baby-at-night/).

Night-time on the post-natal ward

In studying night-time mother-infant behaviour on the postnatal ward of a large UK tertiary hospital we were able to build on our descriptive research with experiments. In a series of randomised trials we manipulated maternal-infant night-time proximity to examine the effects on feeding, sleeping and mothers' ability to care for their infants. Although rooming-in (mothers and babies sharing a hospital room) is standard practice in UK postnatal units, we found that typical new-born bassinets hinder breastfeeding initiation, and are barriers to mother-infant interaction. Mothers and babies that we randomly allocated to bed-share or to use side-car cribs (3-sided cribs attached to the edge of the mother's bed) breastfed more frequently than those allocated to normal rooming-in. Facilitating frequent feeding in the early post-partum period increases prolactin production, which in turn influences the timing and intensity of lactogenesis II (onset of copious milk production).[9] Women whose milk supply is established early and copiously are known to have more confidence in their breastfeeding ability, and their babies are less likely to receive early supplementation with formula. While the UK practice of rooming-in is better than removal of babies to new-born nurseries (as still happens in the US), we showed that providing mother and baby with unhindered access to one another is most effective for breastfeeding initiation following vaginal delivery.[10]

Both midwives and breastfeeding support organisations readily engaged with our evolution-informed post-natal unit intervention to promote mother-new-born night-time proximity – the relationship between frequent feeding, increased night-time prolactin production, timing and strength of lactogenesis II, and breastfeeding confidence were all familiar parts of their practice. Our innovation was simply to remove the barrier between mother and baby posed by the standard new-born bassinette on the premise that separation by such barriers does not support the evolved biology of the mother-infant dyad. This research has changed practice across UK

post-natal units that have purchased side-car cribs and implemented 'bedding-in' policies to facilitate breastfeeding initiation (e.g. [11]).

Is 'safe bed-sharing' possible?

In studying evolution-informed solutions to the night-time dilemmas of parents with young infants we engaged with the continued debate around safe/unsafe parent-infant sleep behaviours. During the recent 10–15 year period when parents in the UK were strongly cautioned against sleeping with their babies (as they currently are in the US), we considered why and how parents might implement potentially risky infant care strategies.[12]

While some safer sleep guidance seems to suggest that certain sleep environments are lethal to infants whenever they occur, parents quickly learn that most infants can sleep in a variety of environments with no adverse outcomes, and they tolerate potential risks in exchange for other benefits. There is a statistical association between sleep-sharing and unexpected infant death[1] under a number of circumstances. For this reason some authorities urge parents to ensure their babies always sleep alone in separate cribs. While accidental deaths tend to cluster in well-known hazardous situations (e.g. on sofas where babies can become wedged, or when sleeping with an intoxicated adult), SIDS (Sudden Infant Death Syndrome, referring to a sudden and unexplained infant death occurring during sleep) deaths occur wherever babies sleep, peaking at 2-3 months of age (the 'critical developmental period'). The Triple Risk Model explains how SIDS deaths occur when a vulnerable infant is exposed to an external stressor during this critical phase, and SIDS risk-reduction guidance encourages parents to avoid particular sleep environments (e.g. prone sleep, soft bedding) for all babies. This serves to reduce exposure to various evolutionarily-novel sleep environments known to suppress regular arousals, thereby presenting physiological challenges that some infants are unable to cope with.[13]

Safe sleep campaigns strongly cautioned parents against bed-sharing, because it is one factor that may increase an infant's chance of experiencing an external stressor (e.g. airway covering). We wondered why, if bed-sharing was uniformly hazardous for babies, as these campaigns claimed, there wasn't more sleep-related mortality among breastfed babies, given that we had shown these were the babies most likely to sleep in their parents' bed. Our research discovered that breastfeeding mothers who sleep with their babies protect them from such stressors by their characteristic sleep position (curled around their babies, making a constrained sleep-space with their bodies) while other researchers have documented mothers' continued vigilance via micro-arousals which prompt regular infant arousals through-out the night.[14, 15]

Figure 2. Breastfeeding mothers sleep with their babies in a characteristic way (Ball 2006).

An evolution-informed perspective acknowledges the role of investment trade-offs and the constraints of maternal-infant biology in shaping human parental care. Limiting parental care options by 'prohibiting' particular care behaviours has unintended consequences such as

reducing breastfeeding duration and/or increasing parental sleep deprivation. This suggests that a 'risk minimisation' approach to infant sleep safety, with information for parents facilitating informed choice about the trade-offs they might make, is preferable to a 'risk elimination' approach – a fact now recognised in UK recommendations.

Translating evolution-informed evidence into practice

Our parent-infant sleep research has used an evolution-informed understanding of mother-infant biology and parent-infant conflict to devise and trial interventions in night-time infant care, and to challenge maternal and infant health care practitioners in the UK to implement new ways of thinking. Our evolutionary-based explanations of lactation biology, mother-infant feeding and sleeping behaviour, and maternal coping strategies have provided the evidence-base that policy-makers and health professionals need to support a growing emphasis on the needs of new-born babies, lactating mothers, and sleep-deprived fathers. We have encouraged clinicians and public health policy-makers to use the concept of investment trade-offs to understand why parents pursue particular night-time care strategies, and to consider the impact of implementing overly rigid recommendations on parents and babies.[12]

The UK Baby-friendly Initiative (a maternal-infant health programme operated by UNICEF UK, and recommended by the UK Department of Health) first used and publicised our research and evolutionary approach to night-time infant care almost two decades ago. Uptake of our research outputs swiftly spread to NHS Trusts, other parent support organisations, and governmental health policies. Our research is now used in maternal and infant health care around the world (see https://www.dur.ac.uk/sleep.lab/impact/).

We hope that learning about what our small team has accomplished will encourage others to apply evolution-informed thinking to the improvement of health policy and practice.

References cited

1. Ball HL, CK Russell (2012). Night-time nurturing: an evolutionary perspective on breastfeeding and sleep. In *Evolution, Early Experience and Human Development: From Research to Practice and Policy*. Narvaez, D., Panksepp, J., Schore, A., & Gleason, T. (Eds.) New York: Oxford University Press.
2. Volpe LE, HL Ball, JJ McKenna (2013). Night-time Parenting Strategies and Sleep-Related Risks to Infants. *Social Science and Medicine* Special issue on 'Sleep and Health' 79:92-100.
3. Russell CK, LE Volpe, HL Ball (2016) Sudden Infant Death Syndrome. *Evolutionary thinking in Medicine: from research to policy and practice*. Ed by A. Alvergne, C. Jenkinson, C. Faurie. Springer
4. Tully KP, HL Ball (2013). Trade-offs underlying maternal breastfeeding decisions: a conceptual model. *Maternal & Child Nutrition* 9(1): 90-98
5. Ball HL (2002) Reasons to bed share: Why parents sleep with their infant. *Journal of Reproductive and Infant Psychology* 20(4) 207-222.
6. Ball HL (2003) Breastfeeding, Bed-Sharing, and Infant Sleep. *Birth* 30(3):181-8.
7. Ball, HL, Howell, D., Bryant, A., Best, E., Russell, C. & Ward-Platt, M. (2016). Bed-sharing by breastfeeding mothers: who bed-shares, and what is the relationship with breastfeeding duration?. *Acta Paediatrica* 105(6): 628-634.
8. Victora, C. G. et al. (2016). *The Lancet* 387, 475–490.
9. Ball HL. (2008). Evolutionary Paediatrics: a case study in applying Darwinian Medicine. In *Medicine and Evolution: Current Applications, Future Prospects*. Elton, S. & O'Higgins, P. New York: Taylor & Francis. 127-152.
10. Ball HL, Ward-Platt MP, Heslop E, Leech SJ & Brown KA (2006). Randomised trial of infant sleep location on the postnatal ward. *Archives of Disease in Childhood* 91(12): 1005-1010.
11. Lomax C (2008) Bedside cots keep your dearest nearest. *Telegraph & Argus* (Newspaper) 19.2.2008 http://www.thetelegraphandargus.co.uk/news/2054041.bedside_cots_keep_your_dearest_nearest/ accessed 3.12.16
12. Volpe, LE, & Ball, HL. (2015). Infant sleep-related deaths: why do parents take risks? *Archives of Disease in Childhood*, 10(7), 603–604.

13. Ball, HL, & Russell, CK. (2014). SIDS and Infant Sleep Ecology. *Evolution, Medicine, and Public Health*, 2014(1), 146. http://doi.org/10.1093/emph/eou023
14. Ball HL (2006) Parent-infant bed-sharing behavior. *Human Nature* 2006; 17(3):301-318
15. McKenna JJ; HL Ball; Lee T Gettler (2007) Mother–Infant Co-sleeping, Breastfeeding and Sudden Infant Death Syndrome. *Yearbook of Physical Anthropology*, 50:133–161